Physical and Data Link Layer

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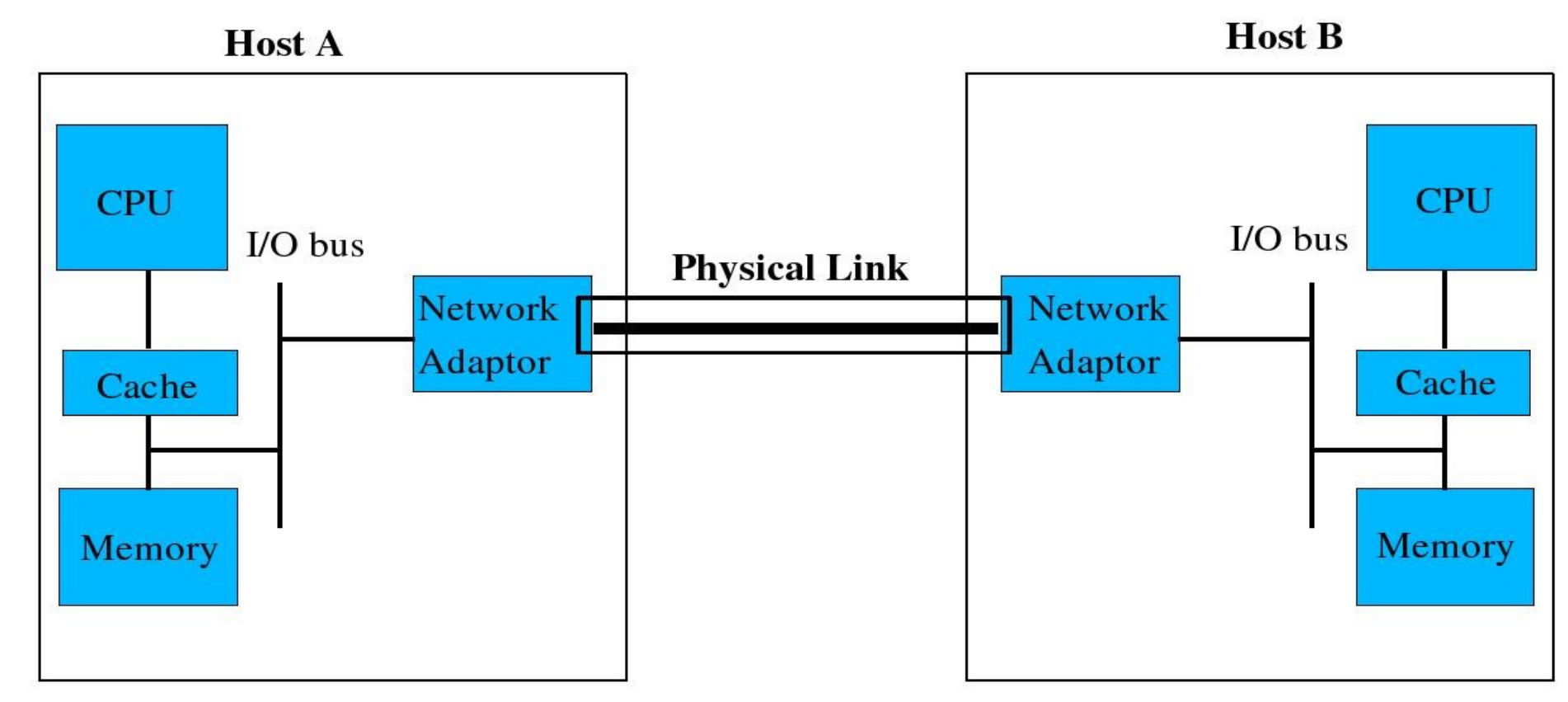
Problem Statement

- Make two computers talk to each other

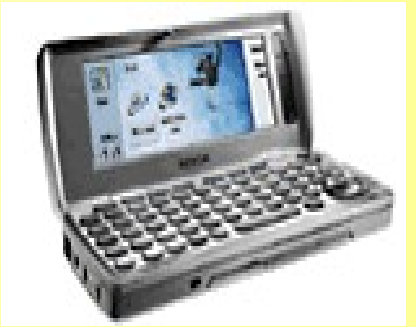


Pictures courtesy Peterson & Davie

Hosts

Communication end-points

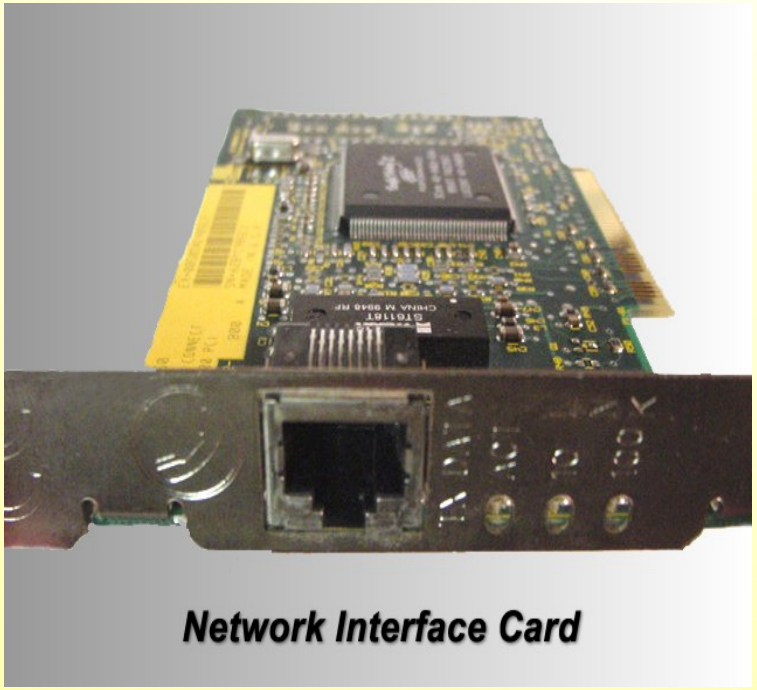
- PCs, Workstations, PDAs, Cellphones, Servers



Pictures courtesy Google

Interface Cards/Network Adaptor

Attach the host to the link

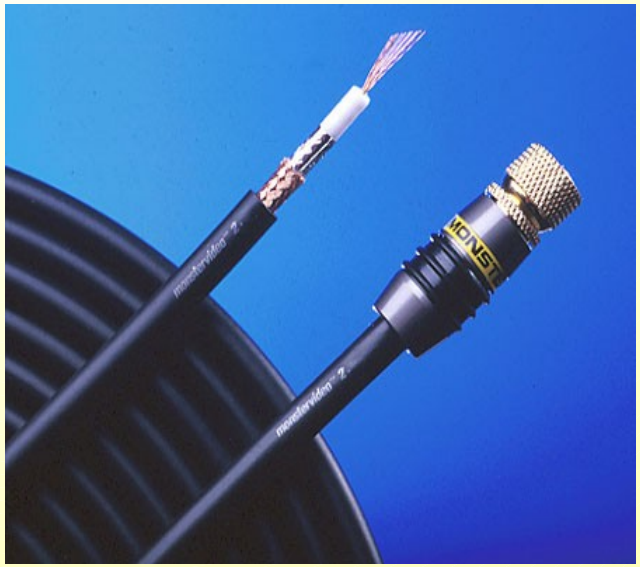


Pictures courtesy Google

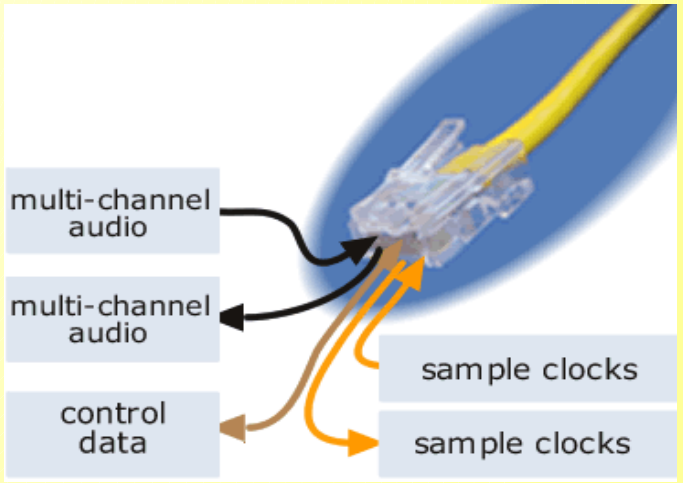
Links

Carry signals from one place to other place(s)

Fiber Optics



Co-axial



Cat5-twisted pair

Pictures courtesy Google

Characteristics of Links

- Data Rate
- Loss rate
- Delay

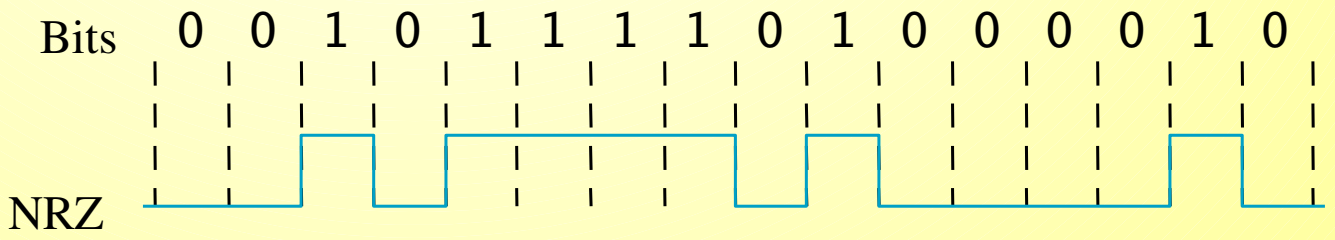
Link Type	Typical Bandwidths	Distance
Twisted Pair	10-100 Mbps	100m
Coaxial Cable	10-100 Mbps	200-500m
Fiber Optics	100-2400 Mbps	40kms

Shannon's Theorem

- Signals attenuate with distance
- Get distorted due to noise, crosstalk, fading, multi-path
- Signal to Noise Ratio (SNR) measures these effects
- C = W log_2 (1 + S/N) bits/sec
- Data over telephone line calculation
- W = 3300Hz – 300Hz = 3000Hz; S/N = 1000 (30db); C ~ 30kbps

Encoding

- Physical media transmit ***Analog*** signals
- Modulate/demodulate:
  - Encode/decode binary data into signals
  - E.g. Non-return to Zero (NRZ)
    - 0 as low signal and 1 as high signal



Picture courtesy Peterson & Davie

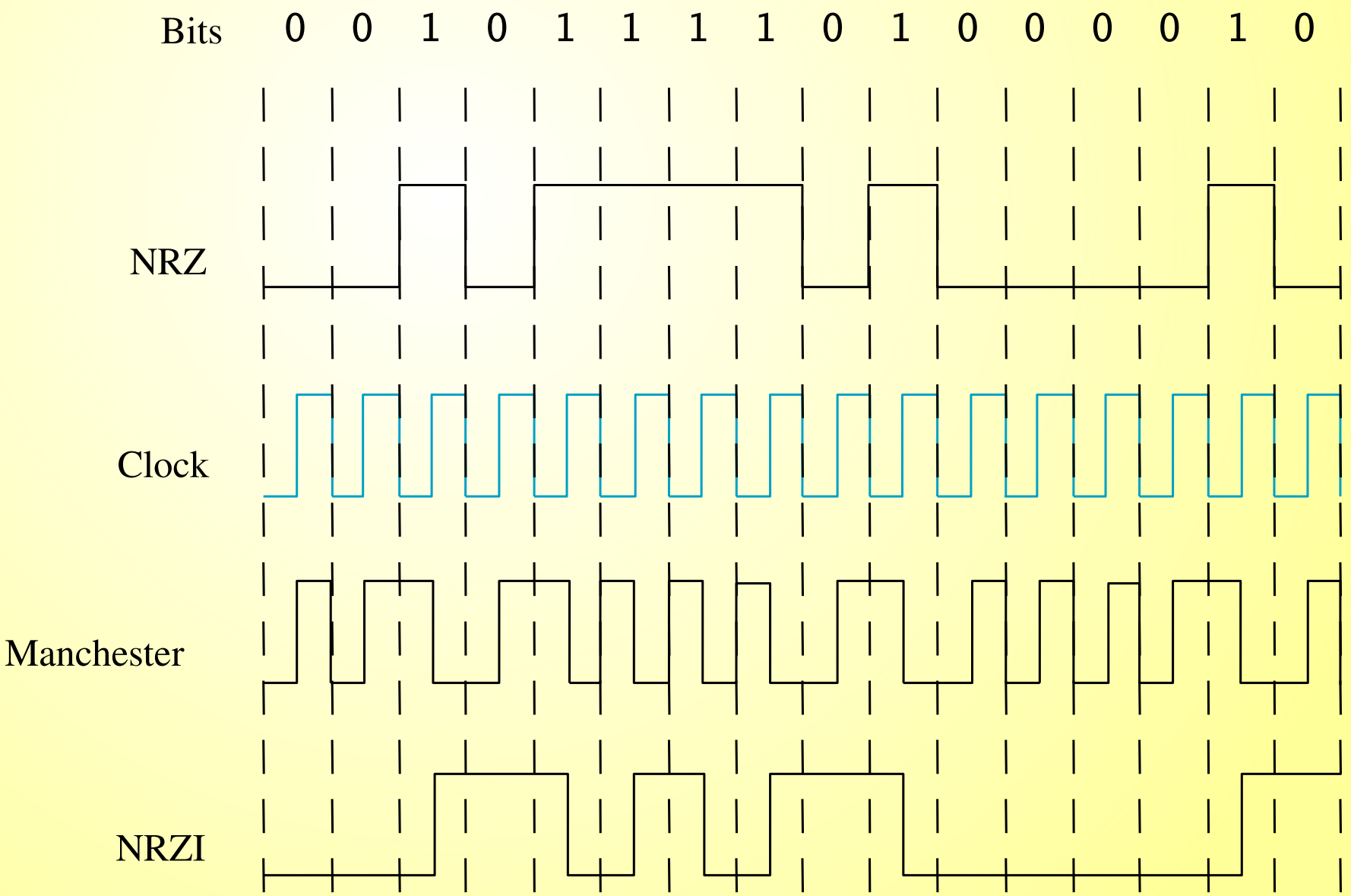
Problems with NRZ

- Consecutive 1s and 0s
  - Changes the average making it difficult to detect signals (*baseline wander*)
  - Clock Recovery
    - Sender's and receiver clocks have to be precisely synchronized
    - Receiver derives the clock from the received signal vis signal transition
    - Lesser number of transitions leads to clock drift

Alternative Encodings

- Non-return to Zero Inverted (NRZI)
  - To encode a 1, make a transition
  - To encode a 0, stay at the current signal
  - Solves problem of consecutive 1's but not 0's
- Manchester Encoding
  - Transmits XOR of the NRZ encoded data and the clock
    - 0 is encoded as low-to-high transition, 1 as high-to-low transition
  - Only 50% efficient

Example



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